Con. 3183-09.

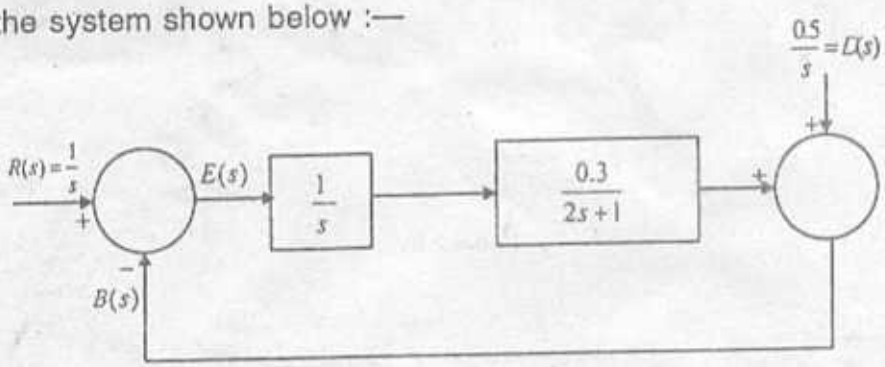
(3 Hours) [Total Marks : 100

N.B. (1) Question No. 1 is **compulsory**.
(2) Attempt any **four** questions from the **rest**.
(3) **All** question carry **equal** marks.
(4) Assume **suitable** data wherever **necessary**.

Passed B.E(E) VIII Sem Industrial Controllers. 29/5/09 MASTER

1. Answer the following :— 20
   (a) Explain the scan cycle of PLC.
   (b) Define proportional band and derive the expression for the same.
   (c) Explain the ON delay timer instruction used in PLC.
   (d) Explain steps involved in choice of controllers structure.
   (e) Explain the series and parallel forms of PID.

2. (a) For the system shown below :— 10



   (i) Find the damping ratio, natural frequency of the system.
   (ii) Find the steady state error due to reference and due to disturbance.

   (b) Explain the windup effect and suggest a remedy to remove the same. 10

3. (a) Draw and explain what is the difference between wiring a sourcing and sinking output ? 10
   (b) Explain in details data files used in PLC. 10

4. (a) A simple boiler system is modeled by a second order transfer function with d.c. gain of unity damping ratio of 0·2 and natural frequency of 0·5 rad/sec. Design a PID controller using pole placement method such that the dominant second order closed loop pole at $s = -0{\cdot}7 \pm j0{\cdot}7$. 10
   (b) Write the step for tuning of proportional & derivative control of a process with simple type 1 model. 10

5. (a) Develop Ladder Logic for a car door/seat belt safety system. When the car door is open, or the seatbelt is not done up, a buzzer will sound for 5 seconds if the key has been switched on. A cabin light will be switched on when the door is open and stay on for 10 seconds after it is closed, unless a key has started the ignition power. 10
   (b) Explain BCD number system supported by PLC using BCD representation for four digit decimal values. 10

6. (a) Starting with analog PID controller formula derive the controller formula for digital PID. 10
   (b) Explain with neat diagram the working of relay experiment for PID tuning. And hence write PID rule base for same. 10

7. Write short note on following (any **four**) :— 20
   (a) Sequencer
   (b) Addressing technique used in PLC
   (c) Trouble shooting in PLC
   (d) Fixed and Modular PLC
   (e) Derivative kick and Proportional kick and suggest connection to avoid.

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BE (E) sem VIII (R)

Drives & controls

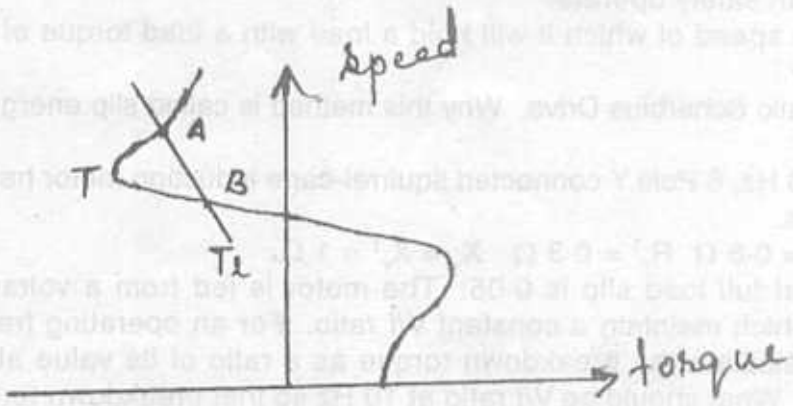
Con. 2652-09. VR-4113

(REVISED COURSE)

(3 Hours) [Total Marks : 100

N.B.: (1) Question No. **1** is **compulsory**.
(2) Attempt any **four** questions out of remaining **six** questions.
(3) Assume suitable **data** if **necessary** and justify.

1. (a) Draw the block diagram of an Electrical drive. Explain the functions of power modulator. 20
(b) A motor of smaller rating can be selected for a short time duty. Why ?
(c) Comment on the stability of the operating points A and B.



(d) Calculate the starting time of a drive with following parameters
$J = 10$ kg-m^2 $T = 15 + 0{\cdot}5\ W_m$ $TI = 5 + 0{\cdot}6\ W_m$

2. (a) Explain Intermittent Periodic Duty. Give two examples. 4
(b) Derive over load factor for intermittent periodic duty. 6
(c) Explain with examples the steady state stability of an equilibrium point and show that an equilibrium point will be stable when an increase in speed causes load torque to exceed the motor torque. 10

3. (a) For a single phase fully controlled rectifier control of dc separately excited motor. 10
(i) Draw circuit diagram.
(ii) Draw voltage and current waveforms in continuous mode.
(iii) Explain its operation.
(iv) Draw speed-torque characteristics and mark continuous and discontinuous conduction region for different 'α'.
(v) What are the different quadrant of operation possible ? Explain with neat circuit diagram.
(b) Explain the operation of Dual converter control of dc separately excited motor. 10

[TURN OVER

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Con. 2652-VR-4113-09.

4. (a) Explain motoring mode, regenerative braking and dynamic braking of a chopper controlled dc series motor. 10

(b) A 200 V, 10·5 A, 2000 rpm shunt motor has the armature and field resistances of 0·5 and 400 Ω respectively. It drives a load whose torque is constant at rated motor torque. Calculate motor speed if the source voltage drops to 175 V. 10

5. (a) Explain with neat diagram ac dynamic braking of a three phase induction motor. 10

(b) A 3-phase 440V, 50 Hz 6 pole Y connected induction motor has following parameters referred to the stator $R_s = 0{\cdot}5\ \Omega$, $R_r^1 = 0{\cdot}6\ \Omega$, $X_s = X_r^1 = 1\ \Omega$. 10
If the motor is used for the regenerative braking, determine.

(i) Maximum overhauling torque it can hold and the range of speed in which it can safely operate.

(ii) The speed of which it will hold a load with a load torque of 160 N-m.

6. (a) Explain Static Scherbius Drive. Why this method is called slip energy recovery scheme ? 10

(b) A 440 V, 50 Hz, 6 Pole Y connected squirrel-cage induction motor has following parameters. 10

$R_s = 0{\cdot}6\ \Omega$ $R_r^1 = 0{\cdot}3\ \Omega$ $X_s = X_r^1 = 1\ \Omega$.

The normal full load slip is 0·05. The motor is fed from a voltage source inverter, which maintain a constant V/f ratio. For an operating frequency of 10 Hz. Calculate the breakdown torque as a ratio of its value at the rated frequency. What should be V/f ratio at 10 Hz so that breakdown torque at this frequency remains the same as at rated frequency.

7. Write short notes on any **two** :— 20

(a) Any two power factor improvement method

(b) Brushless DC motor.

(c) Synchronous motor variable speed drives.

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BE (E) Sem VIII (R) 25/5/09
Elective II Project Management

762 : H-m.

Con. 3194-09. (REVISED COURSE) VR-4128

Page (1) (3 Hours) [Total Marks : 100

N.B. (1) Answer any **five** questions.
(2) Answers should be **brief** and to the **point**.
(3) **Figures** to the **right** indicate **full** marks.

1. (a) Define 'Project' and 'Project Management'. 5
   (b) Draw and explain project life cycle. 5
   (c) What are the different methods of determining financial feasibility ? 10

2. (a) You are the project manager for industrial visit of your class. Carry out WBS for this project up to three levels for any of the two milestones chosen by you. 10
   (b) Explain briefly tools and techniques for 'Total Quality Management'. 10

3. (a) Select project of your choice and carryout SWOT analysis for the same. 10
   (b) What is meant by 'Project Scope Management' ? Explain. 5
   (c) What are the elements of commercial terms and conditions for a tender ? 5

4. (a) List the various aspects of 'Human Resource Management'. 10
   (b) What are the preferred qualities of a project manager ? 10

5. (a) Explain the features of different types of contracts in brief for Procurement Management. 10
   (b) Explain the importance of project closing process. List the major documents required during 'Project closure'. 10

6. A project is given below, crash it to the optimum level and comment upon the result. Assume indirect cost as Rs. 1000 per week. 20

Activity	Predecessor	Duration in weeks		Cost in Rs.	
		Normal	Crash	Normal	Crash
A	—	9	6	20000	26000
B	—	8	5	15000	24000
C	A	5	4	12000	13000
D	A	8	6	18000	28000
E	B	7	3	14000	22000
F	C	5	4	13000	16000
G	E	5	2	17000	32000

7. Write short notes on any **two** :— 20
   (a) Project Risk Management
   (b) Project Management Software
   (c) Logistics in Procurement Management.

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N.B. : (1) Question No. 1 is **compulsory**.
(2) Attempt any **four** questions out of remaining **six** questions.
(3) **All** the questions carry **equal** marks.
(4) Assume **suitable** data wherever **necessary**.

1. (a) What is 'Load Compensation' ? Describe the objectives of load compensation in detail. 10

(b) Show that the voltage sensitivity for load reactive power is $\frac{dv}{dQ_l} = -\frac{E/ssc}{1 + Kr \cdot E/ssc}$ 10

2. (a) Using short circuit fault level of a system obtain the approximate relationship between system voltage and reactive power. 10

(b) Define the terms :— 10

(i) Stiff system (ii) S.I.L.

(iii) Ferranti Effect (iv) Current and voltage profile.

3. (a) Prove that the surge impendance loading of the line has flat voltage profile. 10

(b) Write short note on tap changing transformer and booster transformer as a compensator. 10

4. (a) Explain shunt compensation by synchronous voltage source. 10

(b) Using phasor diagram to illustrate different operation of UPFC. 10

5. (a) Explain, how a compensator is used for regulation of voltage of bus in power system. 10

(b) Show that for a symmetrical line the mid-point voltage is higher than terminal voltage if it is loaded less than natural load i.e. $P < P_o$. 10

6. (a) Explain the operation and V-I characteristics of TCR. 10

(b) Compare :— 10

(i) Static compensation with dynamic compensation.

(ii) Passive compensation with active compensation.

7. (a) Explain the effect of series compensator on power angle curve. Draw the P-S diagram for various degree of compensation. 10

(b) A 3-ϕ, 60 Hz transmission line is 150 mi long. The line is connected to a load of 50 mVA at a power factor of 0·8 lagging. Line constants are given as:– $R = 0{\cdot}185\Omega$/mi; L= 2·60 mH/mi and C = 0·012 μF/mi 5

Calculate :- Attenuation constant and phase constant per mile of line.

(i) Wave length and velocity of propagation.

(ii) SIL of the transmission line, if line is assumed loss free.

(c) Draw and explain in short Voltage/Reactive power characteristics of partially compensated system. 5

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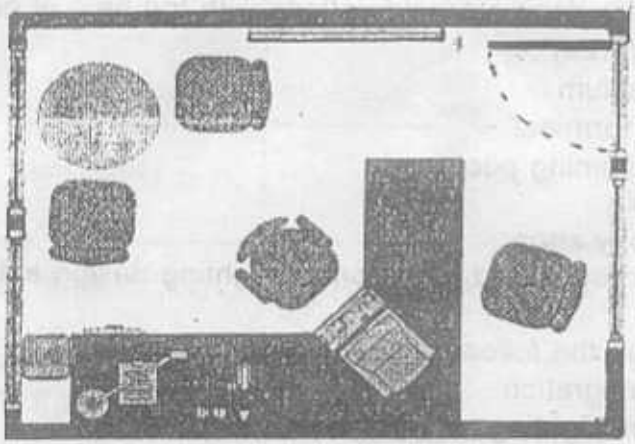
(3 Hours) [Total Marks : 100

N.B. (1) Question No. **1** is **compulsory.**
(2) Answer any **four** out of remaining **six** questions.
(3) **Assumptions** made should be **clearly** stated.
(4) Assume any **suitable** data wherever **required** but **justify** the same.
(5) **Figures** to the **right** indicate marks.
(6) Illustrate **answers** with **sketches** wherever **required.**

Passed B.E (E) VIII Sem Illumination Engg 25/5/09. MASTER

1. Consider a layout of an office shown below with dimensions 6 mt x 4 mt x 3·5 mt. Describe the design considerations for lighting systems you will recommend. Clearly state the considerations for selection of luminaries and placement of the same. Design complete lighting system satisfying all the design consideration mentioned. Draw all the necessary lighting layouts. Refer the COU chart and lamp data provided. What special care you will take to achieve very low glare (Glare quality class A). **20**



2. (a) Define and describe the following parameters. **12**
   (i) Luminance
   (ii) Luminous Intensity
   (iii) Horizontal Illuminance
   (iv) Vertical Illuminance
   (v) Inverse square law
   (vi) Luminous efficacy.
   (b) Describe the energy flow diagram for following lamps indicating electrical wattage distribution against various losses and percentage radiations (any **two**) :— **8**
   (i) GLS lamp
   (ii) Fluorescent lamp
   (iii) HPMV lamp
   (iv) HPSV lamp.

3. (a) Describe the working of control gear circuitry for the following lamps (any **two**) :— **8**
   (i) Fluorescent lamp
   (ii) HPMV lamp
   (iii) Metal Halide Lamp.
   (b) Explain the following terms with the help of suitable sketches/examples (any **three**) :— **12**
   (i) Scotopic vision and Photopic vision
   (ii) Color Rendering Index (CRI)
   (iii) Visual Ambiance
   (iv) Lighting Power Density (LPD).

4. (a) What are the different classification of lamps and luminaries ? **10**
   (b) What is Emergency lighting ? What are the design considerations for it ? **10**

[TURN OVER

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5. Design the lighting scheme for a major road having two way traffic with divider. The road has a large number of turns along the complete stretch (zigzag nature). The specifications are as following :— 20

Total width of the road = 20 meters, No of lanes = 6
Width of the divider = 2 meters, Stretch of the road = 4 Km

Clearly specify all quantitative and qualitative design considerations for above application. Assume suitable data if necessary. Clearly specify the selection and justification for following :—

(i) Type of arrangements of poles
(ii) Lamp and luminaries
(iii) Pole height and spacing
(iv) Number of poles and lamps
(v) Electrical Load of lighting scheme designed and monthly energy consumptions in rupees.
(Assume 9 working hours per day and Rs. 6·00/ unit)

6. (a) State and explain the design considerations with the help of neat sketches for the following (any **three**) :— 15
(i) Cricket stadium
(ii) Container terminal
(iii) Indoor Swimming pool
(iv) Art gallery
(v) Gold Jewelry shop.

(b) What are the advantages and limitations of lighting design software ? 5

7. (a) Write short notes on the following (any **two**) :— 12
(i) Daylight integration
(ii) Facade floodlighting
(iii) Goniophotometer
(iv) Maintenance strategies of lighting system.

(b) Explain the different means and ways that can be adopted to achieve the energy efficient lighting system installation. 8

Data for Illumination Design problems

Coefficient of Utilization Chart

K	Rc=0.7			Rc=0.5			Rc=0.3		
	Rw=0.5	Rw=0.3	Rw=0.1	Rw=0.5	Rw=0.3	Rw=0.1	Rw=0.5	Rw=0.3	Rw=0.1
0	0	0	0	0	0	0	0	0	0
0.6	0.43	0.39	0.36	0.42	0.38	0.36	0.41	0.38	0.36
0.8	0.45	0.41	0.38	0.44	0.40	0.38	0.43	0.40	0.38
1.00	0.51	0.47	0.44	0.55	0.47	0.44	0.49	0.46	0.40
1.25	0.55	0.51	0.49	0.53	0.50	0.48	0.52	0.50	0.48
1.50	0.57	0.54	0.52	0.56	0.53	0.51	0.54	0.52	0.50
2.00	0.61	0.58	0.56	0.59	0.57	0.55	0.57	0.56	0.54
2.50	0.63	0.61	0.59	0.61	0.59	0.57	0.59	0.58	0.56
3.00	0.65	0.63	0.61	0.63	0.61	0.59	0.61	0.59	0.58
4.00	0.67	0.65	0.63	0.64	0.63	0.62	0.62	0.61	0.59
5.00	0.68	0.67	0.65	0.65	0.64	0.63	0.63	0.62	0.61

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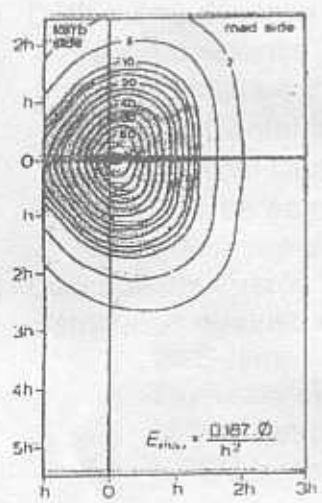
Page (1)

Con. 3195-VR-4122-09.

B.E(E) VII Rev Illumination Engg. 25/5/09 Page (2)

Lamp Data			
Sr.No	Type of Lamp	Wattage	Lumen output
1	GLS	25	230
		40	415
		60	710
		100	1340
		200	3000
2	Tungsten Halogen	50 (Miniature Dichroic)	900
		300	5100
		500	9000
		1000	22000
3	Fluorescent (T8/ T5)	18 (82/84/86)	1300
		36(82/84/86)	3250
		28(T5)	2800
4	CFL	9	600
		11	760
		13	920
		18	1200
		26	1800
5	HPMV	80	3600
		125	6200
		250	12700
		400	22000
		1000	58600
6	Metal Halide	70	5500
		150	12100
		250	20000
		400	36000
7	HPSV	70	5800
		150	13500
		250	25000
		400	47000

Isolux diagram for Road lighting luminaries (Q.No.5)



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Con. 2682-09. 11.00 To 2.00 (REVISED COURSE) VR-4110

Design of Estimation of Ele. sys.

(3 Hours) [Total Marks : 100

Library

N.B. (1) Question No. 1 is **compulsory**.
(2) Attempt any **four** out of remaining.
(3) Assume data if **necessary** and justify the **same**.

Page(1) B.E. (E.E.) VIII Rev Design & Est. & Elect. Syst. 15/5/09.

1. (a) Following are the details of the connected load in a particular plant : 15

MASTER

Type of Load	Load in kW	pf	η	Diversity factor	Load factor
Plant I	800	0·8	0·9	0·65	0·8
Plant II	400	0·85	0·85	0·8	0·7
Plant III	200	0·8	0·9	0·7	0·7
Miscellaneous load	100	0·75	—	0·4	0·8

(i) Draw SLD with location of load and all protective devices.
(ii) Find capacity of distribution transformer.
(iii) Find the size of compensating devices required for three plants.

(b) Define load factor and diversity factor. 5

2. Design a lighting system for a reading room in a library. The dimensions of room are 20 m (L) + 10 m (B) + 3·5 m (H). 20
(a) Sketch the layout of reading tables and chairs.
(b) State design considerations.
(c) Select type of lighting arrangement required.
(d) Select suitable lamps and fixtures required.
(e) Find no. of fixtures required.
(f) Draw lighting layout with reference to the layout of reading tables.

3. (a) What are the different types of distribution systems and their selection criterion ? 10
(b) Explain different types of electrical drawings. 10

4. (a) Explain 'tendering process' in detail. Explain security deposit and earnest money. 10
(b) What is the necessity of energy audit and explain its types and procedure. 10

5. (a) An induction motor of 25 HP, 415 V, three phase, 50 Hz, 0·8 pf lag is to be connected to MCC by a cable at a distance of 15 m. The cable is running with other cables in same cable trays. Ambient temperature is 45°C. The fault level at this point is 40 kA. Calculate the size of conductor. Assume grouping factor and state assumptions. 10

Type of Cable	Value of K (Cu)	Value of K (Al)
PVC cable $\leq$ 300 mm^2	115	76
PVC cable $\geq$ 300 mm^2	103	68
XLPE cable	114	92

(b) How will you convert existing electrical installation in an energy efficient installation. 10

6. (a) What are the steps in project planning ? 10
(b) Explain cable installation in details. 10

7. Write notes on :— 20
(a) Energy efficient motors
(b) Building Mangement Systems
(c) WBS with example.

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DATA SHEET

Lamp Data			
Sr.No	Type of Lamp	Wattage	Lumen output
1	GLS	25	230
		40	415
		60	710
		100	1840
		200	3000
2	Tungsten Halogen	50 (Miniature Dichroic)	900
		300	5100
		500	9000
		1000	22000
3	Fluorescent (T8/ T5)	18 (Halo phosphate)	1015
		36(Halo phosphate)	2450
		18 (82/84/86)	1300
		36(82/84/86)	3250
		28(T5)	2800
4	CFL	9	600
		11	760
		13	920
		18	1200

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TABLE 10

CURRENT RATINGS (ac) FOR TWO, THREE & FOUR CORE 650/1100 Volts, Armoured or un-Armoured Aluminium Conductor Cables as per IS : 3961 (PART II)–1967.

Nominal Area of Conductor mm²	LAID DIRECT					
	IN THE GROUND		IN DUCTS		IN AIR	
	2 Core	3, 3½ & 4 Core	2 Core	3, 3½ & 4 Core	2 Core	3, 3½ & 4 Core
	Amps	Amps	Amps	Amps	Amps	Amps
1.5	18	16	16	14	16	13
2.5	25	21	21	18	21	18
4	32	28	27	23	27	23
6	40	35	34	30	35	30
10	55	46	45	39	47	40
16	70	60	58	50	59	51
25	90	76	76	63	78	70
35	110	92	92	77	99	86
50	135	110	115	95	125	105
70	160	135	140	115	150	130
95	190	165	170	140	185	155
120	210	185	190	155	210	180
150	240	210	210	175	240	205
185	275	235	240	200	275	240
240	320	275	275	235	325	280
300	355	305	305	260	365	315
400	385	335	345	290	420	375

CONDITIONS OF INSTALLATION

Maximum Conductor Temperature	70 °C
Ambient Air Temperature	40 °C
Ground Temperature	30 °C
Depth of Laying for Cables in Ground	75 Cmt.
Thermal Resistivity of soil	150 Cm/Watt.
Method of Installation	Singly

[TURN OVER

TABLE 11

(IEE–Table 9 A)

Recommended methods of installation for cables and conductors

I 'ENCLOSED'

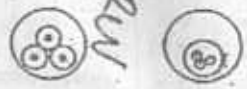
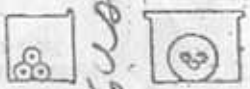
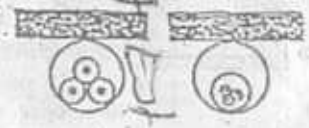
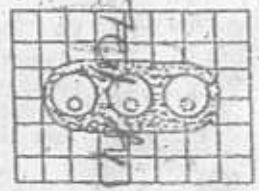
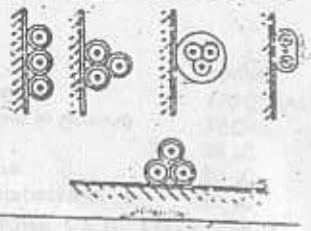
Type	Description	Example
A	Single-core and multicore cables *(enclosed in conduit).*	
B	Single-core and multicore cables *(enclosed in cable trunking).*	
C	Single-core and multicore cables *(enclosed in underground conduit, or ducts, or cable ducting).*	
D	Two or more single-core cables *(contained in separate bores of a multicore conduit and intended to be solidly embedded in concrete or plaster or generally incorporated in the building structure (may be used as a prefabricated wiring system).)*	

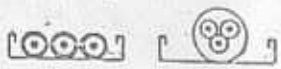
TABLE 11 (Continued.)

II 'OPEN AND CLIPPED DIRECT'

E Sheathed single-core and multicore cables *(clipped direct to or lying on a non-metallic surface).*



F Sheathed single-core and multicore cables *(in a cable tray, bunched and unenclosed).*



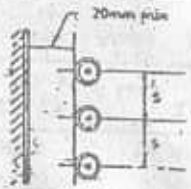
G Sheathed cables *(embedded direct in plaster other than special thermally insulating plasters).*

H Sheathed single-core and multicore cables *(suspended from or incorporating a catenary wire).*

III 'DEFINED CONDITIONS'

J Sheathed single core cables *(in free air).*

Example : *Vertical surface of a wall or open cable trench.*



K Sheathed twin and multicore cables *(in free air).*

Example :
1. *Vertical surface of a wall or open cable trench.*
2. *Cables spaced by a lesser distance are assumed to be 'clipped direct' (see Method E).*

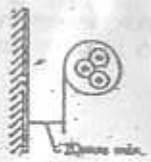
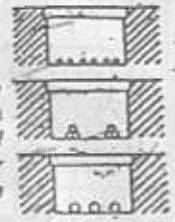


TABLE 11 (Continued.)

IV ENCLOSED TRENCHES

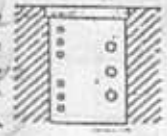
L Single and multicore cables *(enclosed trench 450mm wide by 300mm deep (minimum dimensions) including 100mm cover).*

Example : *Two single-core cables with surfaces separated by a distance equal to one diameter; or three single-core cables in trefoil and touching throughout. Multicore cables or groups of single-core cables separated by a minimum distance of 50mm.*



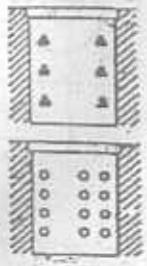
M Single and multicore cables *(enclosed trench 450mm wide by 600mm deep (minimum dimensions) including 100mm cover).*

Example : *Single-core cables arranged in flat groups of two or three on the vertical trench wall with surfaces separated by a distance equal to one diameter with a minimum* separation of 50mm between groups. Multicore cables installed singly separated by a minimum* distance of 75mm. All cables spaced at least 25mm from the trench wall.*



N Single and multicore cables in enclosed trench *(600mm wide by 760mm deep (minimum dimensions) including 100mm cover).*

Example : *Single-core cables arranged in groups of two or three in flat formation with the surfaces separated by a distance equal to one diameter or in trefoil formation with cables touching Groups separated by a minimum* distance of 50mm either horizontally or vertically. Multicore cables installed singly separated by a minimum* distance of 75mm either horizontally or vertically. All cables spaced at least 25mm from the trench wall.*



* Larger spacings to be used where practicable.

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IEE—Table 9C

Correction factors for cables installed in enclosed trenches (installation methods L, M and N of Table 11)

The correction factors tabulated below relate to dispositions of cables illustrated in items L, M, and N of Table 11 and are applicable to current-carrying capacities and volt drops for installation methods J and K of Table 11

Nominal Cross Sectional area of conductor cable	Correction factors — Type L of Table 11				Type M of Table 11			Type N of Table 11		
	Two Single-core cables, or one 3- or 4-core cables	Three single-core cables, or two twin cables	Four single-core cables, or two 3- or 4-core cables	Six single-core cables, four twin cables, or three 3- or 4 core cables	Six Single-core cables, four twin cables, or three 3-or4-core cables	Eight Single-core cables, of four 3- or 4-core cables	Twelve Single-core cables, eight twin cables or six 3- ro 4-core cables	Twelve Single-core cables, eight twin cables or six 3- or 4-core cables	Eighteen Single-core cables twelve twin cables, or nine 3- or 4-core cables	Twentyfour Single-core cables sixteen twin cables, or twelve 3- or 4- core cables
1	2	3	4	5	6	7	8	9	10	11
mm²										
4	0.93	0.90	0.87	0.82	0.86	0.83	0.76	0.81	0.74	0.69
6	0.92	0.89	0.86	0.81	0.86	0.82	0.75	0.80	0.73	0.68
10	0.91	0.88	0.85	0.80	0.85	0.80	0.74	0.78	0.72	0.66
16	0.91	0.87	0.84	0.78	0.83	0.78	0.71	0.76	0.70	0.64
25	0.90	0.86	0.82	0.76	0.81	0.76	0.69	0.74	0.67	0.62
35	0.89	0.85	0.81	0.75	0.80	0.74	0.68	0.72	0.66	0.60
50	0.88	0.84	0.79	0.74	0.78	0.73	0.66	0.71	0.64	0.59
70	0.87	0.82	0.78	0.72	0.77	0.72	0.64	0.70	0.62	0.57
95	0.86	0.81	0.76	0.70	0.75	0.70	0.63	0.68	0.60	0.55
120	0.85	0.80	0.75	0.69	0.73	0.68	0.61	0.66	0.58	0.53
150	0.84	0.78	0.74	0.67	0.72	0.67	0.59	0.64	0.57	0.51
185	0.83	0.77	0.73	0.65	0.70	0.65	0.58	0.63	0.55	0.49
240	0.82	0.76	0.71	0.63	0.69	0.63	0.56	0.61	0.53	0.48
300	0.81	0.74	0.69	0.62	0.68	0.62	0.54	0.59	0.52	0.46
400	0.80	0.73	0.67	0.59	0.66	0.60	0.52	0.57	0.50	0.44
500	0.78	0.72	0.66	0.58	0.64	0.58	0.51	0.56	0.48	0.43
630	0.77	0.71	0.65	0.56	0.63	0.57	0.49	0.54	0.47	0.41

TABLE 13

IEE-Table 9D1

Current-carrying capacities and associated voltage drops for single-core p.v.c. -insulated cables, non-armoured, with or without sheath (copper conductors)

Conductor operating temperature : 70°C

conductor cross Sectional area	Installation methods A to C of Table 11 ('Enclosed')				Installation methods E to H of Table 11 ('Clipped direct')				Installation method J of Table 11 ('Defined conditions')					
	2 Cables, single-phase a.c., or d.c.		3 or 4 cables three-phase a.c		2 Cables, single-phase a.c., or d.c.		3 or 4 cables three-phase a.c		Flat or vertical (2 cables, single-phase a.c., or d.c. or 3 or 4 cables three-phase)				Trefoil (3 cables three-phase)	
	Current carrying capacity	Volt drop per ampere per metre	Current carrying capacity	Volt drop per ampere per metre	Current carrying capacity	Volt drop per ampere per metre	Current carrying capacity	Volt drop per ampere per metre	Current carrying capacity	Volt drop per ampere per metre Single-phase d.c.		Three-phase	Current carrying capacity	Volt drop per ampere per metre
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
mm²	A	mV	A	mV	A	mV	A	mV	A	mV	mV	mV	A	mV
1.0	14	42	12	37	17	42	16	37	-	-	-	-	-	-
1.5	17	28	14	24	21	28	20	24	-	-	-	-	-	-
2.5	24	17	21	15	30	17	26	15	-	-	-	-	-	-
4	32	11	29	9.2	40	11	36	9.2	-	-	-	-	-	-
6	41	7.1	37	6.2	50	7.1	45	6.2	-	-	-	-	-	-
10	55	4.2	51	3.7	68	4.2	61	3.7	-	-	-	-	-	-
16	74	2.7	66	2.3	90	2.7	81	2.3	-	-	-	-	-	-
25	97	1.7	87	1.5	118	1.7	106	1.5	-	-	-	-	-	-
35	119	1.3	106	1.1	145	1.3	130	1.1	-	-	-	-	-	-
		a.c. a.c.				a.c. a.c.								
50	145	0.97 0.91	125	0.84	175	0.93 0.91	160	0.82	195	0.95	0.91	0.85	170	0.80
70	185	0.71 0.63	160	0.62	220	0.65 0.63	200	0.59	240	0.68	0.63	0.62	210	0.59
95	230	0.56 0.45	195	0.48	270	0.48 0.45	240	0.45	300	0.52	0.45	0.49	260	0.42
120	260	0.48 0.36	220	0.42	310	0.40 0.36	280	0.38	350	0.44	0.36	0.43	300	0.34
150	-	- -	-	-	355	0.34 0.29	320	0.34	410	0.39	0.29	0.39	350	0.29
185	-	- -	-	-	405	0.29 0.24	365	0.30	470	0.35	0.24	0.36	400	0.25
240	-	- -	-	-	460	0.24 0.18	430	0.27	560	0.36	0.18	0.38	480	0.22
300	-	- -	-	-	560	0.22 0.14	500	0.25	660	0.33	0.14	0.35	570	0.19
400	-	- -	-	-	680	0.20 0.12	610	0.24	800	0.30	0.12	0.33	680	0.17
500	-	- -	-	-	800	0.18 0.086	710	0.23	910	0.28	0.086	0.31	770	0.16
630	-	- -	-	-	910	0.17 0.068	820	0.22	1040	0.26	0.068	0.30	880	0.15

CONNECTION FACTORS

FOR AMBIENT TEMPERATURE

Ambient temperature	25°C	30°C	40°C	45°C	50°C	55°C	60°C	65°C
Correction factor	1.06	0.94	0.87	0.79	0.71	0.61	0.50	0.35

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TABLE 1

IEE-Table 9D2

Current-carrying capacities and associated voltage drops for twin and multicore p.v.c. -insulated cables, non-armoured (copper conductors)

Conductor operating temperature : 70°C

Conductor Cross sectional area	Installation methods A to C of Fig. 1 ('Enclosed')				Installation methods E to H of Fig. 1 ('Clipped direct')					Installation method K of Fig. 1 ('Defined conditions')					
	One twin cable With or without protective conductor single-phase a.c. or d.c.		One three-core cable with or without protective conductor or one four-core cable, three phase		One Twin cable With or without protective conductor single-phase a.c. or d.c.			One three-core cable with or without protective conductor or one four-core cable, three phase		One Twin cable With or without protective conductor single-phase a.c. or d.c.			One three-core cable with or without protective conductor or one four-core cable, three phase		
	Current carrying capacity	Volt drop per ampere per metre	Current carrying capacity	Volt drop per ampere per metre	Current carrying capacity	Volt drop per ampere per metre		Current carrying capacity	Volt drop per ampere per metre	Current carrying capacity	Volt drop per ampere per metre		Current carrying capacity	Volt drop per ampere per metre	
1	2	3	4	5	6	7		8	9	10	11		12	13	
mm²	A	mV	A	mV	A	mV		A	mV	A	mV		A	mV	
1.0	14	42	12	37	15	42		13	37	-	-		-	-	FLAT
1.5	18	28	16	24	20	28		17	24	-	-		-	-	CABLES
2.5	24	17	21	15	28	17		24	15	-	-		-	-	ONLY
4	32	11	29	9.2	36	11		32	9.2	-	-		-	-	
6	40	7.1	36	6.2	46	7.1		40	6.2	-	-		-	-	
10	53	4.2	49	3.7	64	4.2		54	3.7	-	-		-	-	
16	70	2.7	62	2.3	85	2.7		71	2.3	-	-		-	-	
25	79	1.8	70	1.6	100	1.8		90	1.6	114	1.8		95	1.6	
35	98	1.3	86	1.1	132	1.3		115	1.1	139	1.3		122	1.1	
50	-	-	-	-	163	0.92		140	0.81	172	0.92		148	0.81	
70	-	-	-	-	207	0.65	0.64	176	0.57	218	0.65	0.64	186	0.57	
95	-	-	-	-	251	0.48	0.46	215	0.42	265	0.48	0.48	227	0.42	
120	-	-	-	-	290	0.40	0.36	251	0.34	306	0.40	0.36	285	0.34	
150	-	-	-	-	330	0.32	0.25	287	0.29	348	0.32	0.25	302	0.29	
185	-	-	-	-	380	0.29	0.23	330	0.24	400	0.29	0.23	348	0.24	
240	-	-	-	-	450	0.25	0.18	392	0.20	474	0.25	0.18	413	0.20	
300	-	-	-	-	520	0.23	0.14	450	0.18	548	0.23	0.14	474	0.18	
400	-	-	-	-	600	0.22	0.11	520	0.17	632	0.22	0.11	548	0.17	

CORRECTION FACTORS

FOR AMBIENT TEMPERATURE								
Ambient temperature	25°C	35°C	40°C	45°C	50°C	55°C	60°C	65°C
Correction factor	1.06	0.94	0.87	0.79	0.71	0.61	0.50	0.35

TABLE 15

IEE-Table 9D3

Current-carrying capacities and associated voltage drops for twin and multicore armoured p.v.c. -insulated cables (copper conductors).

Conductor operating temperature : 70°C

Conductor cross sectional area	Installation method E, F and G † of Table 11 ('Clipped direct')					Installation method K of Table 11 ('Defined conditions')				
	One twin cable single phase a.c. or d.c.			One three - or- four core cable three-phase		One twin cable single phase a.c. or d.c.			One three - or- four core cable three-phase	
	Current carrying capacity	Volt drop per ampere per metre		Current carrying capacity	Volt drop per ampere per metre	Current carrying capacity	Volt drop per ampere per metre		Current carrying capacity	Volt drop per ampere per metre
1	2	3		4	5	6	7		8	9
mm²	A	mV		A	mV	A	mV		A	mV
1.5	20	29		18	25	-	-		-	-
2.5	29	18		24	16	-	-		-	-
4	37	12		31	9.6	-	-		-	-
6	48	7.4		41	6.3	50	7.3		42	6.3
10	66	4.3		56	3.8	69	4.3		58	3.8
16	86	2.7		73	2.3	90	2.7		77	2.3
25	115	1.8		97	1.6	121	1.8		102	1.6
35	142	1.3		119	1.1	149	1.3		125	1.1
50	168	0.92		147	0.81	180	0.92		155	0.81
		a.c.	d.c.				a.c.	d.c.		
70	209	0.65	0.64	180	0.57	220	0.65	0.64	190	0.57
95	257	0.48	0.46	219	0.42	270	0.48	0.40	230	0.42
120	295	0.40	0.36	257	0.34	310	0.40	0.36	270	0.34
150	337	0.32	0.25	295	0.29	355	0.32	0.25	310	0.29
185	390	0.29	0.23	333	0.24	410	0.29	0.23	350	0.24
240	461	0.25	0.18	399	0.20	485	0.25	0.18	420	0.20
300	523	0.23	0.14	451	0.18	550	0.23	0.14	475	0.18
400	589	0.22	0.11	523	0.17	620	0.22	0.11	650	0.17

CORRECTION FACTORS

FOR AMBIENT TEMPERATURE								
Ambient temperature	25°C	35°C	40°C	45°C	50°C	55°C	60°C	65°C
Correction factor	1.06	0.94	0.87	0.79	0.71	0.61	0.50	0.35

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TABLE 18
IEE-Table 9H2

Current-carrying capacities and associated volt drops for 85°C or 150°C rubber-insulated flexible cables
Conductor operating temperature : 75°C

Nominal cross sectional area of conductor	Maximum diameter of wires forming conductor	Current-carrying capacity: d.c. or single-phase a.c. (one twin cable, with or without earth-continuity conductor, or two single-core cables bunched)	Current-carrying capacity: Three-phase a.c. (one three, four, or five core cable	Volts drop per ampere per metre: d.c.	Volts drop per ampere per metre: Single-phase a.c.	Volts drop per ampere per metre: Three-phase a.c.
1	2	3	4	5	6	7
mm²	mm	A	A	mV	mV	mV
4	0.31	40	34	13.0	13.0	11.5
6	0.31	51	44	7.9	7.9	7.2
10	0.41	70	60	4.6	4.6	4.2
16	0.41	93	81	2.9	2.9	2.6
25	0.41	120	105	1.9	1.9	1.7
35	0.41	145	125	1.3	1.3	1.2
50	0.41	185	160	0.93	0.95	0.85
70	0.51	225	195	0.65	0.68	0.61
95	0.51	270	235	0.49	0.53	0.47
120	0.51	305	270	0.38	0.43	0.38
150	0.51	355	305	0.31	0.36	0.31
185	0.51	405	350	0.26	0.32	0.27
240	0.51	465	405	0.20	0.27	0.22
300	0.51	530	470	0.16	0.24	0.19
400	0.51	630	-	0.12	0.21	-
500	0.61	720	-	0.10	0.20	-
630	0.61	830	-	0.08	0.19	-

CORRECTION FACTOR FOR AMBIENT TEMPERATURE

85°C rubber-insulated cables: Ambient temperature	35°C	40°C	45°C	50°C	55°C	60°C	65°C	70°C
Correction factor	0.93	0.86	0.80	0.72	0.63	0.54	0.44	0.31

150°C rubber-insulated cables: Ambient temperature	35°C to 95°C	100°C	105°C	110°C	115°C	120°C	125°C	130°C	135°C	140°C
Correction factor	1.0	0.94	0.88	0.82	0.77	0.71	0.64	0.58	0.48	0.39

Note - BS 6007 does not include 150°C rubber-insulated cables above 16mm² nominal cross-sectional area

TABLE 19
IEE-Table 9J3

Current-carrying capacities and associated volt drops for heavy duty mineral-insulated cables (copper conductors and sheath) (BS 6207, Part 1) exposed to touch or having an overall covering of p.v.c.
Sheath operating temperature : 70°C

Nominal Cross sectional area of conductor	Two single-core cables, single-phase a.c., or d.c.		Three or four single-core cables, three phase a.c.		One twin cable, single-phase a.c., or d.c.		One three-core, cable, three-phase a.c.		One four-core cable, three-phase a.c.		One seven-core cable, all cores fully loaded		
	Current carrying capacity	Volt drop per ampere per metre	Current carrying capacity	Volt drop per ampere per metre	Current carrying capacity	Volt drop per ampere per metre	Current carrying capacity	Volt drop per ampere per metre	Current carrying capacity	Volt drop per ampere per metre	Current carrying capacity	Volt drop per ampere per metre	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
mm²	A	mV	A	mV	A	mV	A	mV	A	mV	A	mV	mV
1.0	23	42	20	36	19	42	16	36	16	36	11	42	36
1.5	29	28	25	24	24	28	20	24	20	24	14	28	24
2.5	39	17	34	14	32	17	26	14	27	14	19	17	14
4	50	10	44	9.0	41	10	34	9.0	35	9.0	24	10	9.0
6	63	6.9	56	6.0	53	6.9	44	6.0	45	6.0	-	-	-
10	85	4.2	75	3.6	71	4.2	59	3.6	61	3.6	-	-	-
16	110	2.6	99	2.3	94	2.6	78	2.3	81	2.3	-	-	-
25	150	1.7	130	1.4	124	1.7	105	1.4	110	1.4	-	-	-
35	180	1.2	160	1.0	-	-	-	-	-	-	-	-	-
50	225	0.83	200	0.72	-	-	-	-	-	-	-	-	-
70	275	0.59	240	0.51	-	-	-	-	-	-	-	-	-
95	330	0.44	290	0.38	-	-	-	-	-	-	-	1.ph.	3. ph.
120	380	0.35	335	0.30	-	-	-	-	-	-	-	a.c., or	a.c.
150	440	0.28	385	0.24	-	-	-	-	-	-	-	d.c.	-

CORRECTION FACTORS

FOR AMBIENT TEMPERATURE

Ambient temperature	25°C	35°C	40°C	50°C	60°C
Correction factor for cables exposed to touch	1.06	1.0	0.85	0.68	0.46
Correction factor for cables having overall p.v.c. covering	1.16	1.1	0.94	0.75	0.51

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TABLE 20
IEE-Table 9K1
Current-carrying capacities and associated voltage drops for single-core p.v.c. -insulated cables, non-armoured, with sheath (Aluminium conductors)

Conductor operating temperature : 70°C

Cross sectional area of conductor	Installation methods A to C † of Table 11 ('Enclosed') — 2 Cables, single-phase a.c., or d.c. — Current carrying capacity	Volt drop per ampere per metre a.c.	Volt drop per ampere per metre d.c.	3 or 4 cables three-phase a.c. — Current carrying capacity	Volt drop per ampere per metre	Installation methods E to H of Table 11 ('Clipped direct') — 2 Cables, single-phase a.c., or d.c. — Current carrying capacity	Volt drop per ampere per metre a.c.	Volt drop per ampere per metre d.c.	3 or 4 cables three-phase a.c. — Current carrying capacity	Volt drop per ampere per metre	Installation method J of Table 11 ('Defined conditions') — Flat or vertical (2 cables, single-phase a.c., or d.c. or 3 or 4 cables three-phase) — Current-carrying capacity	Volt drop per ampere per metre 1 ph	Volt drop per ampere per metre d.c.	Volt drop per ampere per metre 3 ph.	Trefoil (3 cables three-phase) — Current carrying capacity	Volt drop per ampere per metre
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
mm²	A	mV	mV	A	mV	A	mV	mV	A	mV	A	mV	mV	mV	A	mV
16	60	4.5	4.5	52	3.9	72	4.5	4.5	65	3.9	-	-	-	-	-	-
25	78	2.9	2.8	67	2.5	94	2.8	2.8	85	2.5	-	-	-	-	-	-
35	96	2.1	2.0	83	1.8	115	2.1	2.0	105	1.8	-	-	-	-	-	-
50	120	1.6	1.5	100	1.4	143	1.5	1.5	123	1.3	155	1.5	1.5	1.34	140	1.3
70	150	1.2	1.0	125	1.0	481	1.1	1.0	156	0.93	190	1.1	1.0	0.95	170	0.90
95	175	0.93	0.75	150	0.80	223	0.77	0.75	193	0.69	235	0.80	0.75	0.72	205	0.67
120	205	0.80	0.60	175	0.70	261	0.62	0.60	225	0.56	275	0.65	0.60	0.60	235	0.54
150	235	0.73	0.49	200	0.64	298	0.51	0.49	250	0.48	320	0.55	0.49	0.51	270	0.45
185	-	-	-	-	-	345	0.42	0.39	290	0.40	376	0.46	0.39	0.45	310	0.37
240	-	-	-	-	-	411	0.34	0.29	361	0.34	440	0.43	0.29	0.43	370	0.30
300	-	-	-	-	-	476	0.29	0.23	410	0.30	510	0.38	0.23	0.39	435	0.25
380	-	-	-	-	-	554	0.26	0.19	465	0.28	584	0.35	0.19	0.37	490	0.22
480	-	-	-	-	-	643	0.23	0.15	541	0.26	677	0.32	0.15	0.34	570	0.20
600	-	-	-	-	-	737	0.21	0.12	616	0.24	776	0.30	0.12	0.33	648	0.18

CORRECTION FACTORS

FOR AMBIENT TEMPERATURE

Ambient temperature	25°C	35°C	40°C	45°C	50°C	55°C	60°C	65°C
Correction factor	1.06	0.94	0.87	0.79	0.71	0.61	0.50	0.35

TABLE 21
IEE-Table 9K2
Current-carrying capacities and associated voltage drops for twin and multicore armoured p.v.c. -insulated cables, non-armoured (Aluminium conductors)

Conductor operating temperature : 70°C

Conductor cross sectional area	Installation method E, to H † of Table 11 (Clipped direct) — One twin cable single phase a.c. or d.c. — Current carrying capacity	Volt drop per ampere per metre	One three - or- Four core cable, three-phase — Current carrying capacity	Volt drop per ampere per metre	Installation method K of Table 11 ('Defined conditions') — One twin cable, single phase a.c. or d.c. — Current carrying capacity	Volt drop per ampere per metre	One three - or- four core cable, three-phase — Current carrying capacity	Volt drop per ampere per metre
1	2	3	4	5	6	7	8	9
mm²	A	mV	A	mV	A	mV	A	mV
16	62	4.5	53	3.9	65	4.5	55	3.9
25	82	2.9	70	2.5	86	2.9	74	2.5
35	102	2.1	86	1.8	107	2.1	91	1.8
50	120	1.5	106	1.3	125	1.5	110	1.3
70	150	1.1	133	0.93	158	1.1	139	0.93
95	185	0.79	163	0.68	195	0.79	172	0.68
120	-	-	190	0.54	-	-	200	0.54
150	-	-	217	0.45	-	-	227	0.45
185	-	-	247	0.37	-	-	260	0.37
240	-	-	296	0.29	-	-	311	0.29
300	-	-	340	0.25	-	-	358	0.25

CORRECTION FACTORS

FOR AMBIENT TEMPERATURE

Ambient temperature	25°C	35°C	40°C	45°C	50°C	55°C	60°C	65°C
Correction factor	1.06	0.94	0.87	0.79	0.71	0.61	0.50	0.35

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TABLE 22
(IEE-Table 9K2)

Current-carrying capacities and associated voltage drops for twin and multicore p.v.c.-insulated cables, non-armoured (aluminium conductors)

Conductor operating temperature, 70 C

Cross-sectional area of conductor	Installation methods E, F and G of Table 4 ('Clipped direct')					Installation method K of Table 4 ('Defined conditions')				
	One twin cable, single-phase a.c., or d.c.			One three-or four-core cable, three-phase		One twin cable, single-phase a.c., or d.c.			One three-or four-core cable, three-phase	
	Current carrying capacity	Volt drop per ampere per metre		Current carrying capacity	Volt drop per ampere per metre	Current carrying capacity	Volt drop per ampere per metre		Current carrying capacity	Volt drop per ampere per metre
		a.c.	d.c.				a.c.	d.c.		
1	2	3	4	5	6	7	8	9	10	11
mm²	A	mV	mV	A	mV	A	mV	mV	A	mV
16	63	4.5	4.5	55	3.9	66	4.5	4.3	58	3.9
25	83	2.9	2.9	67	2.5	87	2.9	2.9	71	2.5
35	100	2.1	2.0	88	1.8	105	2.1	2.0	93	1.8
50	124	1.6	1.5	105	1.3	130	1.6	1.5	110	1.3
70	157	1.1	1.0	138	0.93	165	1.1	1.0	145	0.93
95	185	0.79	0.77	166	0.68	195	0.79	0.77	175	0.68
120	-	-	-	195	0.54	-	-	-	205	0.54
150	-	-	-	219	0.45	-	-	-	230	0.45
185	-	-	-	257	0.37	-	-	-	270	0.37
240	-	-	-	304	0.30	-	-	-	320	0.30
300	-	-	-	347	0.25	-	-	-	365	0.25

CORRECTION FACTORS

FOR AMBIENT TEMPERATURE								
Ambient temperature	25 C	35 C	40 C	45 C	50 C	55 C	60 C	65 C
Correction factor	1.06	0.94	0.87	0.79	0.71	0.61	0.50	0.35

TABLE 23
(IEE-Table 9K3)

Current-carrying capacities and associated voltage drops for twin and multicore armoured p.v.c. insulated cables (Aluminium Conductors) BS 6346

Conductor operating temperature : 70°C

Nominal Cross Sectional area of conductor	Installation methods E, F and G of Table 9A ('Clipped direct')					Installation method K of Table 9A ('Defined conditions')				
	One twin cables, single phase a.c., or d.c.			One three or four-core cable, three-phase		One twin cable single phase a.c., or d.c.			One Three or four-core cable, three-phase	
	Current carrying capacity	Volt drop per ampere per metre		Current carrying capacity	Volt drop per ampere per metre	Current carrying capacity	Volt drop per ampere per metre		Current carrying capacity	Volt drop per ampere per metre
		a.c.	d.c.				a.c.	d.c.		
1	2	3	4	5	6	7	8	9	10	11
mm²	A	mV	mV	A	mV	A	mV	mV	A	mV
16	63	4.5	4.5	55	3.9	66	4.5	4.3	58	3.9
25	83	2.9	2.9	67	2.5	87	2.9	2.9	71	2.5
35	100	2.1	2.0	88	1.8	105	2.1	2.0	93	1.8
50	124	1.6	1.5	105	1.3	130	1.6	1.5	110	1.3
70	157	1.1	1.0	138	0.93	165	1.1	1.0	145	0.93
95	185	0.79	0.77	166	0.68	195	0.79	0.77	175	0.68
120	-	-	-	195	0.54	-	-	-	205	0.54
150	-	-	-	219	0.45	-	-	-	230	0.45
185	-	-	-	257	0.37	-	-	-	270	0.37
240	-	-	-	304	0.30	-	-	-	320	0.30
300	-	-	-	347	0.25	-	-	-	365	0.25

CORRECTION FACTORS

FOR AMBIENT TEMPERATURE								
Ambient temperature	25°C	35°C	40°C	45°C	50°C	55°C	60°C	65°C
Correction factor	1.06	0.94	0.87	0.79	0.71	0.61	0.50	0.35

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